PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 88TY1318	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/IB2004/002927	International filing date *(day/month/year)* 09.09.2004	Priority date *(day/month/year)* 11.09.2003
International Patent Classification (IPC) or national classification and IPC G01S13/93		
Applicant TOYOTA JIDOSHA KABUSHIKI KAISHA ET AL.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 5 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
24.05.2005	21.10.2005
Name and mailing address of the international preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Niemeijer, R Telephone No. +31 70 340-1038

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No. PCT/IB2004/002927

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

   Description, Pages

   1-20 as originally filed

   Claims, Numbers

   1-10 received on 24.05.2005 with letter of 24.05.2005

   Drawings, Figures

   1-6 as originally filed

   ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-10
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-10
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-10
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following document:
   D1: DE 101 33 945 A (BOSCH GMBH ROBERT) 6 February 2003 (2003-02-06)

2 INDEPENDENT CLAIMS 1, 6

2.1 The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and discloses an object detection system, comprising (the references in parentheses applying to this document):

i. radar detection means that detects an object using a radar (D1: page 4, lines 21-22; figure 3),

ii. image detection means that detects an object using an image (D1: page 4, line 22; figure 3, and

iii. collating means that performs collation between a detection result of the radar detection means and a detection result of the image detection means so as to determine whether an identical object is detected by the radar detection means and the image detection means (D1: page 4, lines 46-61; figure 3);

the object detection system further comprising:

iv. the collating means performs a first collation between an object detected by the radar detection means in a present collation and an object in a previous collation (D1: page 6, lines 65-68);

v. performs a second collation between an object detected by the image detection means in a present collation and an object in the previous collation (D1: page 6, lines 65-68); and

vi. determines whether the radar detection means and the image detection means detect the identical object based on the first and the second collations (D1: page 9, lines 53-60).

The subject-matter of claim 1 differs from this known system in that the first collation and second collation take place **only if** the object of the previous collation was

detected by **both** sensors:

iv. the collating means performs a first collation between an object detected by the radar detection means in a present collation and an object *that has been determined as being detected by the radar detection means **and** the image detection means* in a previous collation;

v. performs a second collation between an object detected by the image detection means in a present collation and an object *that has been determined as being detected by the radar detection means **and** the image detection means* in the previous collation *when it is determined that the identical object is detected by the radar detection means **and** the image detection means in the previous collation*;

The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as:
- how to improve the stability of the sensor data fusion process?

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons. A well known problem in multiple sensor data fusion is the probability that a single object is fused as two distinct objects, or that two distinct objects are fused as a single object. The solution comprises an additional requirement that the association of sensor objects to existing fused objects is allowed *only if* the fused object was detected by *both sensors*. This requirement restricts the association and fusion process and leads to a more stable fusion results.

Document D1 does not disclose nor suggest this requirement. The subject-matter of independent system claim 1 is therefore inventive (Article 33(3) PCT).

2.2 The reasoning set out in point 2.1 also applies to corresponding independent method claim 6. The subject-matter of independent method claim 6 is therefore novel and inventive (Article 33(2)(3) PCT).

3 DEPENDENT CLAIMS 2-5, 7-10

3.1 Claims 2-5 are dependent on independent system claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

3.2 Claims 7-10 are dependent on independent method claim 6 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Claims

1. An object detection system characterized by comprising:

radar detection means (2) that detects an object using a radar,

image detection means (3) that detects an object using an image, and

collating means (4) that performs collation between a detection result of the radar detection means (2) and a detection result of the image detection means (3) so as to determine whether an identical object is detected by the radar detection means (2) and the image detection means (3); the object detection system being characterized in that

the collating means (4) performs a first collation between an object (n_m) detected by the radar detection means (2) in a present collation and an object (n3_pre) that has been determined as being detected by the radar detection means (2) and the image detection means (3) in a previous collation; performs a second collation between an object (n_i) detected by the image detection means(3) in a present collation and an object (n3_pre) that has been determined as being detected by the radar detection means (2) and the image detection means (3) in the previous collation when it is determined that the identical object is detected by the radar detection means (2) and the image detection means (3) in the previous collation; and determines whether the radar detection means (2) and the image detection means (3) detect the identical object (n3') based on the first and the second collations.

2. The object detection system according to claim 1, characterized in that the collating means (4) performs a third collation between objects (n_m - n3') detected by the radar detection means (2) in the present detection, which are obtained by excluding the object (n3') determined as have been detected by the radar detection means (2) and the image detection means (3), and objects (n_i - n3') detected by the image detection means (3) in the present detection, which are obtained by excluding the object (n3') determined as have been detected by the radar detection means (2) and the image detection means (3) such that it is determined whether the identical object (n3'') is detected by the radar detection means (2) and the image detection means (3).

3. The object detection system according to claim 2, characterized in that the collating means (4) determines all fusion objects (n3) in the present collation by adding the number of fusion objects (n3') determined based on the first and second collation (S1) to that of the fusion objects (n3'') determined based on the third collation (S20 to S25) to determine all fusion objects (n3) in the present collation (S3), and the collating means (4) determine all independent objects (n1, n2) in the present collation by excluding the fusion objects (n3) from the objects (n_m, n_i) detected by the radar detection means (2) or the image detection means (3) in the present detection.

4. The object detection system according to any one of claims 1 to 3, characterized in that the radar detection means (2) comprises at least one of a millimeter-wave radar and a laser radar.

5. The object detection system according to any one of claims 1 to 4, characterized in that the image detection means (3) comprises a stereo camera.

6. A method of detecting an object in a system (1) including

radar detection means (2) that detects an object using a radar;

image detection means (3) that detects an object using an image; and

collating means (4) that performs collation between a detection result of the radar detection means (2) and a detection result of the image detection means (3) so as to determine whether an identical object is detected by the radar detection means (2) and the image detection means (3), the method being characterized by comprising the steps of:

performing a first collation (S10, S11) between an object (n_m) detected by the radar detection means (2) in a present collation and an object (n3_pre) that has been determined as being detected by the radar detection means (2) and the image detection means (3) in a previous collation;

performing a second collation (S12, S13) between an object (n_i) detected by the image detection means (3) in a present collation and an object (n3_pre) that has been determined as being detected by the radar detection means (2) and the image detection means (3) in the previous collation when is determined that the identical object is detected by the radar detection means (2) and the image detection means (3) in the previous collation; and

determining whether the radar detection means (2) and the image detection means (3) detects the identical object (n3') based on the first and the second collations (S14).

7. The method according to claim 6, characterized by further comprising the step of

performing a third collation between objects (n_m - n3') detected by the radar detection means (2) in the present detection, which are obtained by excluding the object (n3') determined as have been detected by the radar detection means (2) and the image detection means (3), and objects (n_i - n3') detected by the image detection means (3) in the present detection, which are obtained by excluding the object (n3') determined as have been detected by the radar detection means (2) and the image detection means (3) such that it is determined whether the identical object (n3'') is detected by the radar detection means (2) and the image detection means (3) (S20 to S25).

8. The method according to claim 7, characterized by further comprising the steps of

adding the number of fusion objects (n3') determined based on the first and second collation (S1) to that of the fusion objects (n3'') determined based on the third collation (S20 to S25) to determine all fusion objects (n3) in the present collation (S3); and

excluding the fusion objects (n3) from the objects (n_m, n_i) detected by the radar detection means (2) or the image detection means (3) in the present detection to determine all independent objects (n1, n2) in the present collation (S3).

~~9. The method according to any one of claims 6 to 8,~~ characterized in that the radar detection means (2) comprises at least one of a millimeter-wave radar and a laser radar.

10. The method according to any one of claims 6 to 9, characterized in that the image detection means (3) comprises a stereo camera.